

Follow the Energy

CREATING A CONCEPT MAP

WHAT HAPPENS TO A PACKET OF SOLAR ENERGY ONCE IT REACHES EARTH?

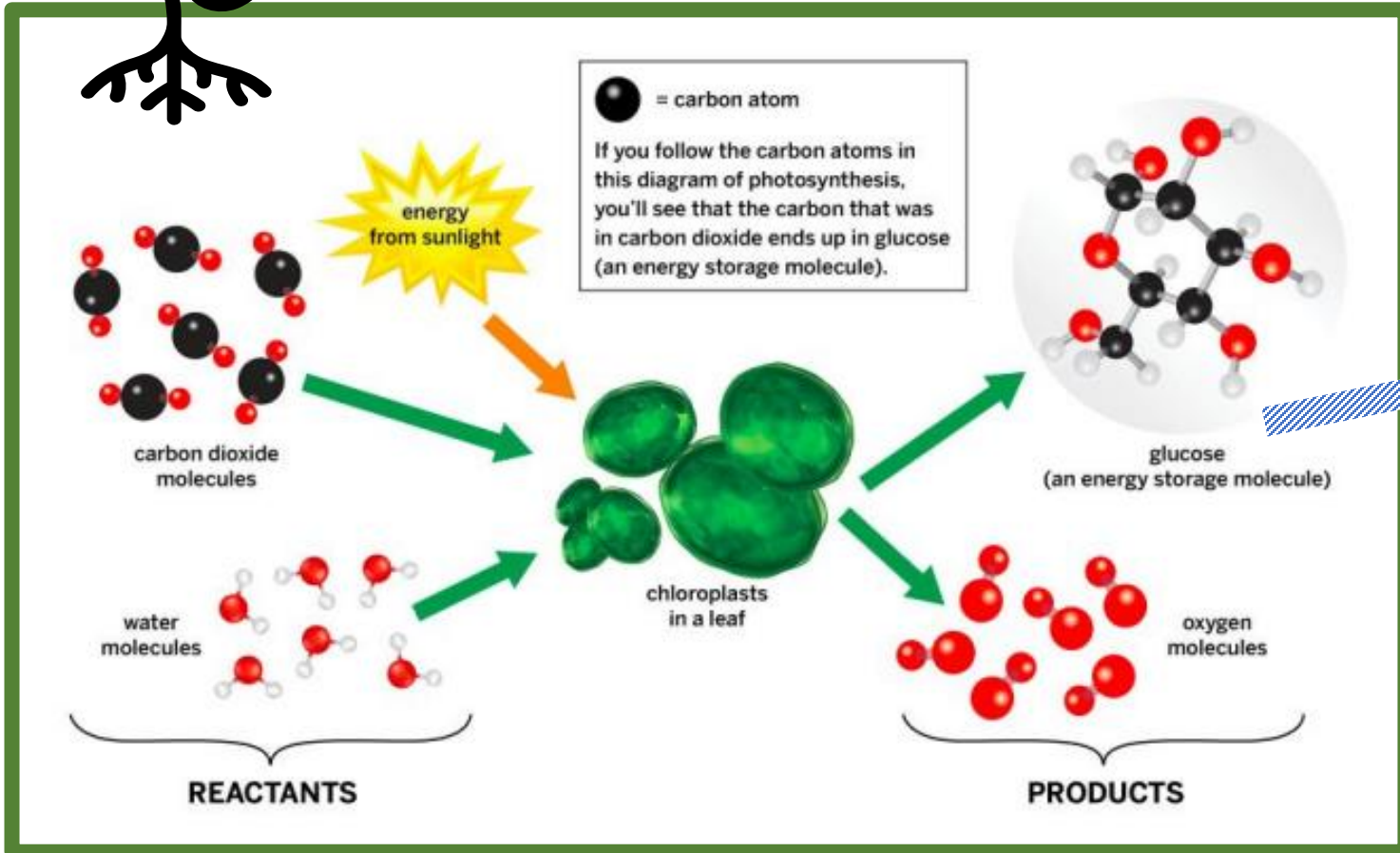
The answer to this question can be simple or very complex, including many steps along the way. For instance, it might be **absorbed** by an object (matter), or it might **reflect** off a surface (changing direction of motion) or it might **change form** such as visible light waves **reradiating** as infrared (heat) waves.

YOUR TASK: Take a moment to respond to this question by writing down a couple of different paths that solar energy might take once it reaches Earth's atmosphere.

- Path 1: Energy packet from Sun travels through space to...
- Path 2: Energy packet from Sun travels through space to...

DID YOU THINK ABOUT SUNLIGHT REACHING A PHOTOSYNTHESIZING PLANT LEAF?

SUNLIGHT ENERGY IS STORED (AS CHEMICAL BONDS)
IN GLUCOSE DURING PHOTOSYNTHESIS



Energy transfers when a
goat eats the plant.
What might be next
for the energy?

OR PERHAPS YOU THOUGHT OF SUNLIGHT REFLECTING OFF THE SURFACE OF WAVES IN THE OCEAN

The same information shown in this photo can be presented as a simple diagram using lines, arrows, and simplified sketches as was done in the previous photosynthesis image.

YOUR TASK: *Imagine where the energy might go next.* Represent the information shown in this photo using a **simple diagram**. Sketch out energy traveling from the sun through space and Earth's atmosphere, striking water waves, then reflecting off the water's surface and finally traveling to an object (of your choice). Use **labels** to identify matter (objects in your diagram) and to explain the energy transfers shown in your diagram.



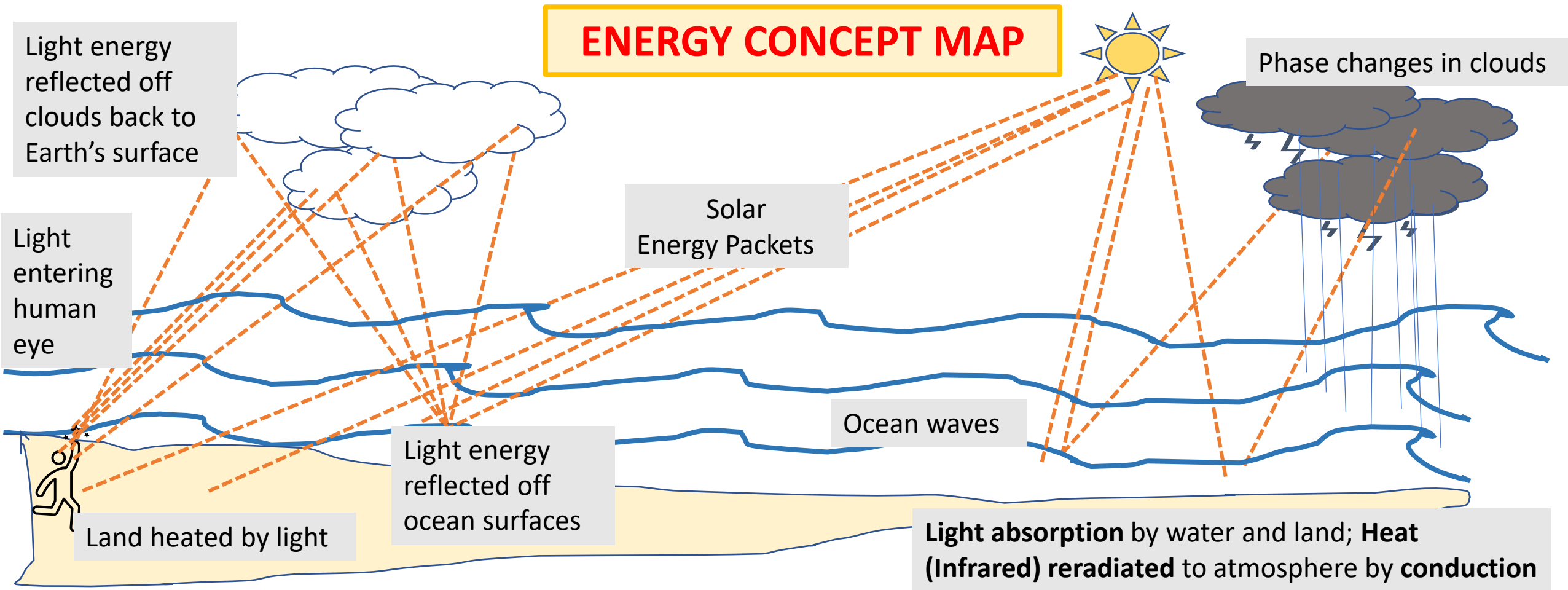
Albert Einstein taught us that energy can neither be created nor destroyed – only converted from one form of energy to another (*LAW of conservation of energy*)

WHAT IS A CONCEPT MAP?

A **CONCEPT MAP** is a 2-dimensional visual organization and representation of knowledge, showing concepts, ideas, and forms of matter as well as indicating the relationships among them.

Both the previous photosynthesis example and the diagram you drew of solar energy passing through Earth's atmosphere to ocean waves and then to another object can be considered **energy concept maps**.

Each of these two concept maps follow energy as it transfers from the Sun to Earth, where it interacts with various types of matter. Energy transfers into and out of matter, such as a plants, water, land, or gases in the atmosphere.



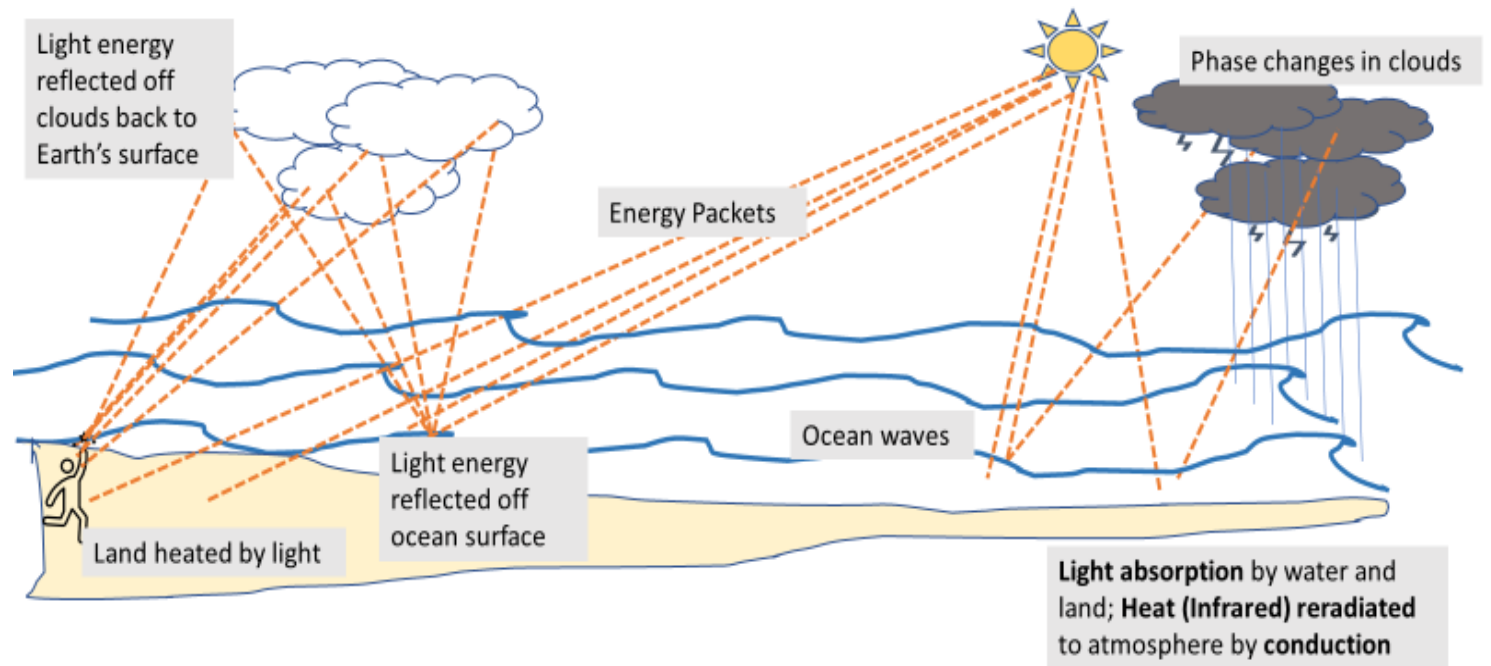
CONCEPT MAPS can seem quite complicated until you break them down into their basic components. Often the symbols or components of a concept maps can be classified into **three categories**:

- **SOURCES**
- **SINKS (RESERVOIRS)**
- **TRANSFORMATIONS (CONNECTORS)**

SOURCE: A source icon begins your path through a concept map. It can be an idea (like a historical event) or raw materials mined to manufacture a product. In the case of our energy concept map, the source is the electromagnetic spectrum of energy from the Sun.

SINK (RESERVOIR): Think storage. These are items in the concept map that hold or store ideas, matter, or energy. The ocean stores much of Earth's water. Fossil fuels store energy from ancient animals and plants. Oceans also store heat energy from the sun. Chemical bonds in compounds serve as sinks for energy.

SOURCES, SINKS AND TRANSFORMATIONS

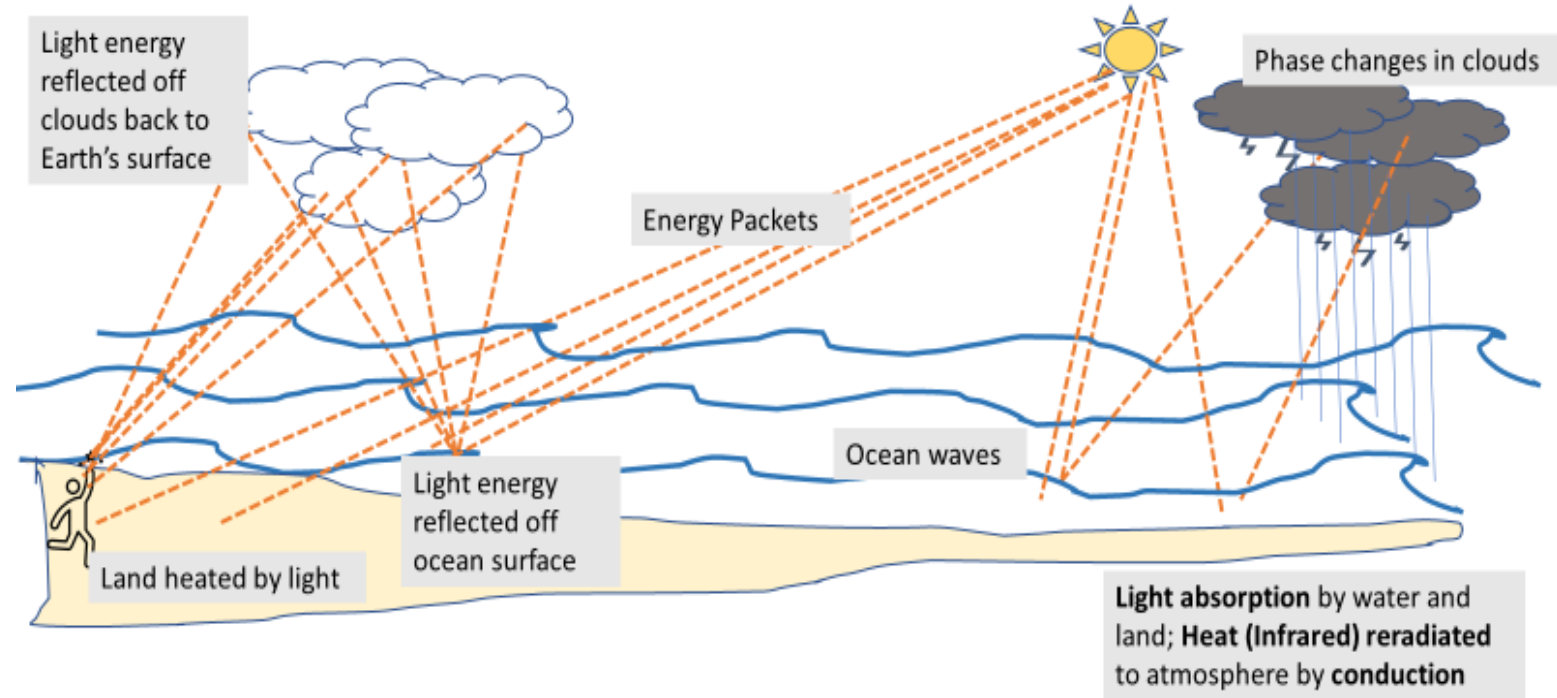


TRANSFORMATIONS: Think of concept maps as *story diagrams*. Transformations between sources and sinks are key to understanding the storyline. They show how matter, energy and even ideas move through other components in a concept map. In the energy concept map, transformations are changes in energy packets. Light energy can change to infrared (heat) energy. Energy moves in and out of clouds during the continuous phase changes in water molecules. In chemical reactions, energy is absorbed when chemical bonds are broken and released when new bonds are formed. Sometimes this released energy is in the form of heat or light energy.

SOURCES, SINKS AND TRANSFORMATIONS

YOUR TASKS:

1. Identify **one energy source** in this concept map.
2. Identify **three energy sinks** in this concept map.
3. Identify **five energy transformations** in this concept map.



TRANSFORMATIONS: Sometimes it helps to use arrows to show movement or direction in the transformations. Where might you add arrows to clarify the movement of energy through this system?

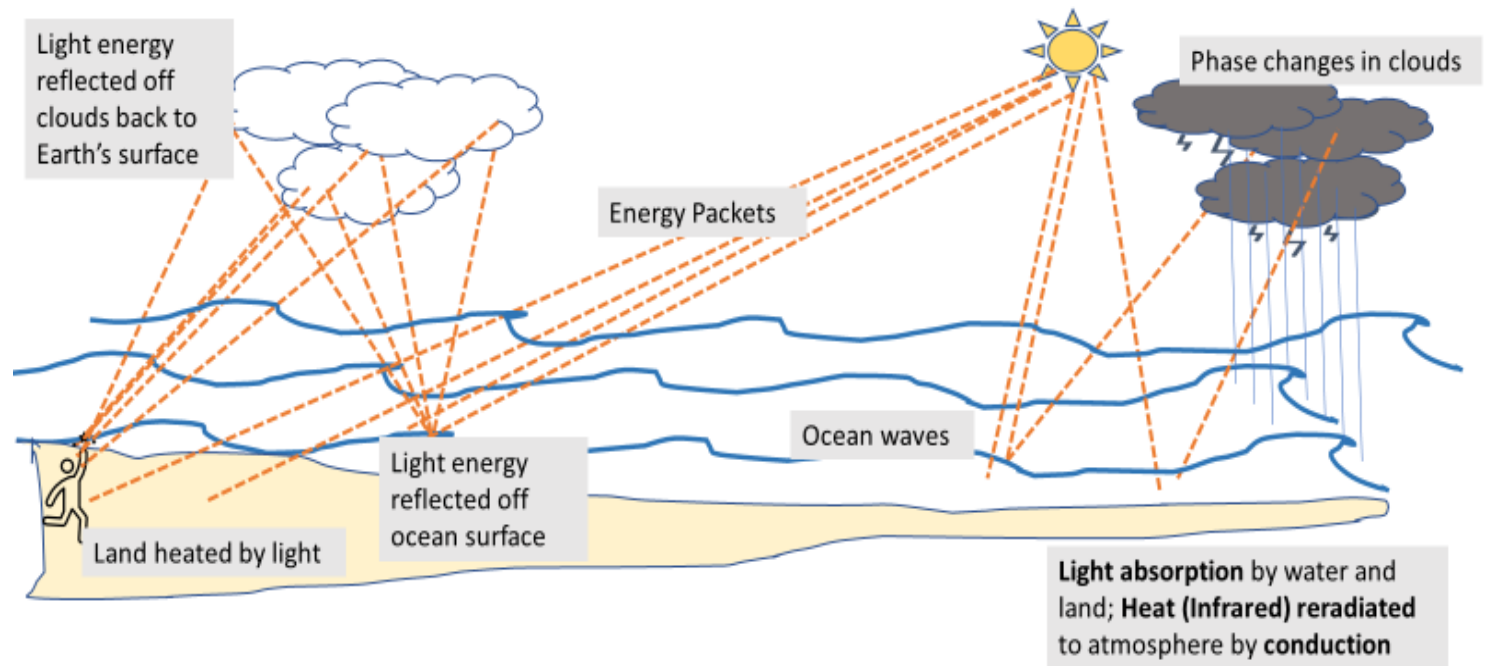
SYSTEMS AND SUBSYSTEMS

Does this concept map seem too complicated or confusing to understand?

Some concept maps show multiple ideas or relationships, diagramming a complex system. In such a case, it helps to break the large system into **subsystems**.

DISCUSSION QUESTIONS:

1. How could you break the information in the diagram into **two subsystems**?
2. What would be the **sources, sinks and transformations** in each subsystem?
3. Does your description of the two subsystems still account for the same amount of total energy that the overall system contained? **Are you still meeting the standard of the Einstein's Law of Conservation of Energy?**



GETTING STARTED

When starting out to construct a concept map for a new problem or idea, it is important to revisit what you already know:

- ✓ Review relevant facts and laws of nature that might inform you about the idea(s) you are investigating.
- ✓ Identify the overall systems, subsystems and processes you wish to include. Sketch out how you want the final map to look so it is easy to follow and interpret.
- ✓ Think about the “story” or “stories” you wish to tell in the sequence of points or subsystems you plan to include.
- ✓ Consider how you will represent the sources, sinks and transformations using labels, explanations and/or symbols. Note that you may need to include a **map key** to define your choice of symbols.

THE FOLLOWING ARE A FEW BASIC CONCEPTS THAT APPLY TO A CONCEPT MAP ABOUT ENERGY AND MATTER:

- **Law of Conservation of Energy:** energy cannot be created or destroyed, only transformed – Albert Einstein
- Matter makes up all visible objects in the universe and it cannot be created or destroyed, only transformed (**Law of Conservation of Matter**) – Antoine Lavoisier
- A **system** can be defined as a group of interacting or interrelated elements that act according to a set of rules to form a unified whole.
 - ✓ Any discussion of an energy system (large or small) includes both matter and energy.
 - ✓ In a chemical reaction, energy is stored or removed as chemical bonds are broken or added between the atoms in the system.
 - ✓ Energy is found in all matter and continuously moves throughout all systems as it is released or absorbed by matter.
 - ✓ Changes in matter such as phase changes (solid, liquid, gas), temperature changes, or chemical reactions are a result of energy moving into the system or moving out of the system.

ADDRESSING GLOBAL WARMING IN YOUR *FOLLOW THE ENERGY CONCEPT MAP*

When exploring energy transfer and energy capture as related to the global warming issue, several significant subsystems help detail the present climate crisis.

Consider including the following topics:

- **Greenhouse Effect** - a natural process regulating Earth's surface & atmospheric temperatures, making Earth habitable for living things; when out of balance it can severely affect global temperatures.
- **Greenhouse Gases** and their **Global Warming Potentials (GWP)**
- **Earth-Atmosphere Energy Budget**
- **Albedo Effect**
- Mechanisms of **Positive and Negative Feedback Loops**